Briggs (W.R.)

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A PAPER

PREPARED FOR THE

THIRD ANNUAL REPORT

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BY

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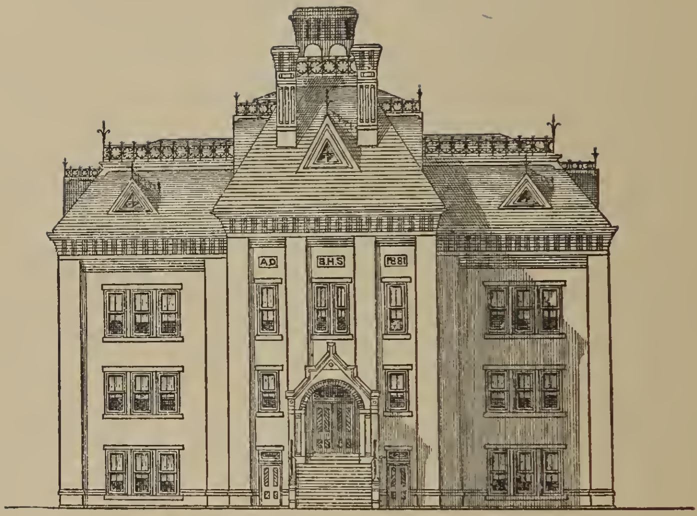
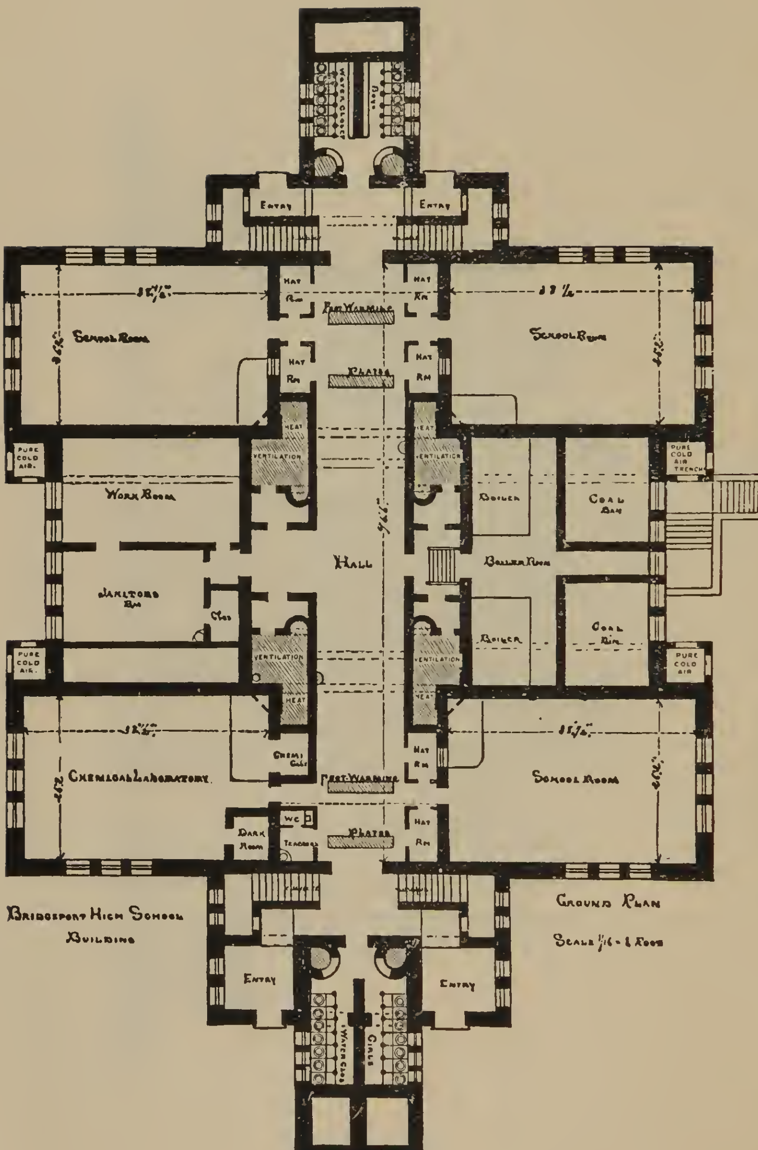


FRONT ELEVATION

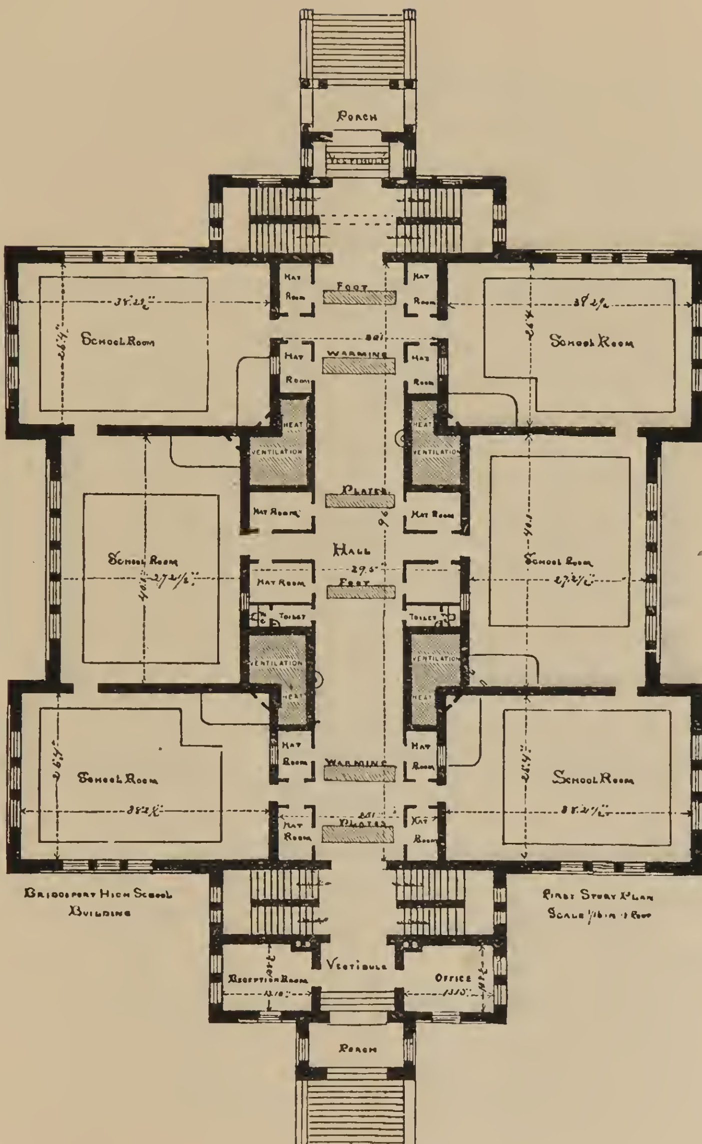
SIDE ELEVATION



Bridgeport High School Building

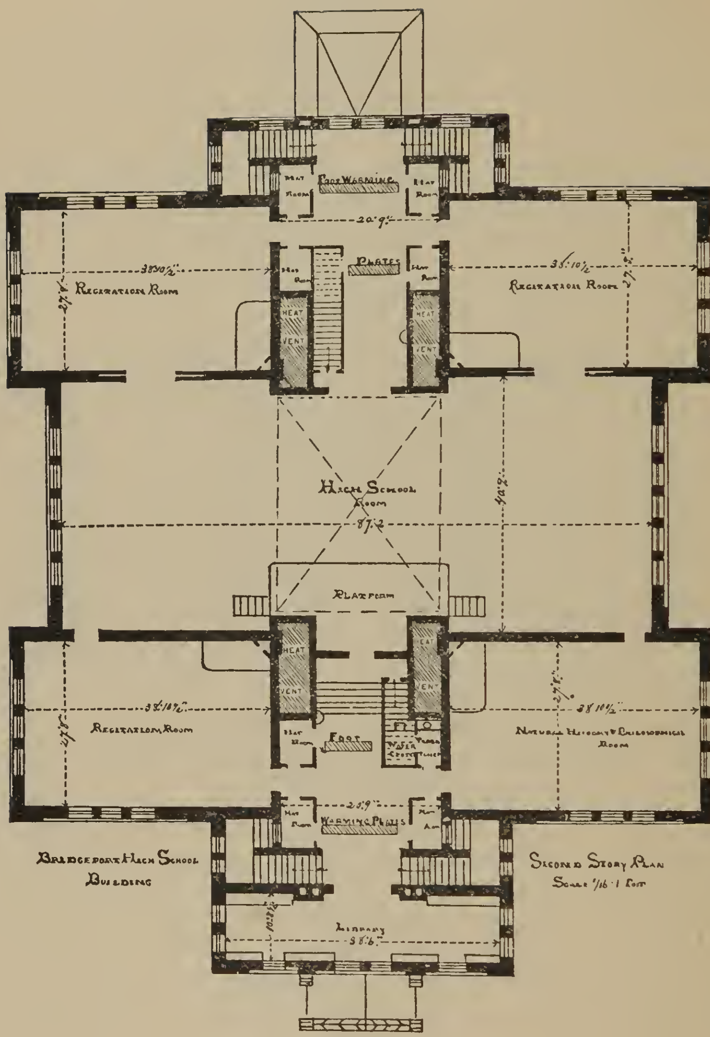
Ground Plan

Scale 1/16 = 1 Foot



Bridgeport High School Building

First Story Plan
Scale 1/16 in = 1 Foot



Bridgeport High School Building

Second Story Plan
Scale 1/16 · 1 Foot

THE HYGIENIC CONSTRUCTION OF THE BRIDGEPORT HIGH SCHOOL BUILDING.

BY WARREN R. BRIGGS, ARCHITECT, BRIDGEPORT, CONN.*

In no department of public or private works is there such vital necessity for a perfect system of hygiene as in the planning, construction, drainage and ventilation of our school buildings. At no time in our lives are we so susceptible to disease as in our school days. The rapid growth of the child, the mental strain that our forcing system of education requires, and the bad sanitary condition of many homes, all tend to weaken the constitution at this period, and render it particularly liable to the contraction of disease. The necessity of abating, as far as possible, and ultimately exterminating, what is known as preventable disease, has become of paramount importance. The alarming spread of malarial diseases and malignant epidemics among children in various parts of the country, I attribute, in the majority of cases, to criminal carelessness in sanitary matters. Miserable construction, poor sewerage, bad plumbing, and no system of ventilation, combine to produce among the poor classes hot-beds for the nursing of the germs of pestilential disease, that are then conveyed by the children to our school-houses. Much has been accomplished by our State and local boards of health to remedy this evil, but there still remains a vast amount of work to be done. Stringent legislation is needed in all matters pertaining to building, and proper officers appointed by the Governor to see that the laws are enforced are required in all

*Reprinted by courtesy of the ~~author and the~~ State Board of Health.

the larger cities of our State. When this is done we may hope to see the erection of the miserable shams, that greedy speculators and unscrupulous landlords now burden us with, stopped. So long as they enjoy the license which the present laws allow them, we can hope for no improvement.

The school-house, where the child spends from four to six hours each day, demands our direct attention. The majority of the pupils in our public schools come from the poorer classes, and are, as a rule, none too cleanly in their personal habits; coming from homes which have none of the luxuries and barely the necessities of life, they are in no condition to be subjected to either excessive heat or extreme cold. Foul air and poor ventilation they have in plenty at their homes, and we should endeavor in the school room to supply them with pure air, uniform temperature, plenty of sunlight, cheerfulness, refinement and comfort; our buildings should be so planned as to combine all of these requirements.

Dr. Lincoln, in his admirable paper recently published in *Buck's Hygiene*, has plainly told us what a school building should be, and the writer has endeavored, as far as lay in his power, to produce a building that shall be a model of its kind. He has not only labored long and faithfully himself, but has consulted the leading experts of the country in regard to the heating, ventilation, and general sanitary arrangements of the building, and has always received from them their hearty approval, coupled with the remark: "We have frequently called the attention of the public, in our articles, to what a building should be, and we are glad to see at last a building planned in accordance with our views."

In all the writer's efforts he has been most ably seconded by the Board of Education of this city, and more especially by the members of the Board who comprise the Building Committee. They are, to a man, whole-souled, enlightened, Christian gentlemen, who have the welfare of the public in view, and although they have been severely criticised and wrongfully assailed, they have unflinchingly put their shoulders to the wheel, and worked with a zeal that cannot be too highly commended to secure for the city a building that can be pointed to with pride, when finished.

The site of the new building is admirable; situated almost in the geographical center of the city, in one of its best localities, far removed from all noise, dust, or odors arising from factories, stables, or the like, being completely isolated on all sides, having no large buildings or trees to shadow it, and standing within a few feet of the highest ground within the city limits, it presents natural advantages that have never been surpassed, and seldom equalled. The lot has an actual elevation of 61.0" above the average high water in the harbor. It has a frontage on two streets of 200', and an average depth of 256 feet, the lot running from street to street. Not only are great advantages obtained by this frontage, in ease of access to the building, but thus are secured unexceptional facilities for the disposal of sewerage, there being a twelve-inch main running down the hill in the center of both streets; in these streets the fall is very rapid, between four and six feet in every hundred.

The principal front (there is no rear) of the building faces Congress street, which, running nearly east and west, gives it a southwesterly exposure. This arrangement secures in every room in the building, during a portion of the day, *sunlight* in abundant quantities.

The building is designed to be constructed of brick, with local stone foundations and underpinnings, brown-stone caps, sills and trimmings, exterior steps to be of granite, and roofs of slate. It will consist of three stories, viz., the ground floor, first story and second story. It contains a total of fourteen school and recitation rooms, a chemical laboratory, reception-room, office, library, janitor's room, work and boiler-room, beside the water-closets.

The height of all rooms in the building, with the exception of the High School room, is 13.0", the High School room having a height of 28.0" in center, and 21.0" on the sides.

The writer does not consider it necessary to go into a detailed explanation of each floor-plan, but will simply call attention to some of the novel features and general construction of the building. The plans themselves illustrate sufficiently the general position and arrangement of rooms and halls.

The ground floor is located two steps, or about fifteen inches, below the grade of the lot. This, under ordinary circumstances, would be considered an objection, on the plea of dampness, but the floor and side walls have been so carefully prepared that the rooms situated on this floor are expected to be the driest in the building.

In the first place, the ground itself is unusually free from dampness; ample provision has, however, been made for the removal of all surface-water by the introduction of six inch drain pipes, laid with open joints, in trenches filled with loose stone, the stones covering the top of the pipe a few inches. These pipes run all around the building, just outside of the foundation wall, and are then carried to the manholes, where they are connected with the main sewer above the running-trap.

The ground under the floor of the school rooms situated on the ground-floor is first cemented 2½ inches with the best Rosendale cement, and then covered with two coats of asphaltum. This asphalt is put on hot, and not only covers the entire bottom, but runs up on all outside and inside walls to the height of the copings, and is then carried across the top of all interior and exterior walls, forming an impenetrable protection against dampness. Not only is the ground-floor and the walls to the height of the coping treated in this manner, but all outside walls in the building—they are all coated to their full height and width with two coats before they are furred. This I believe to be a more perfect safeguard against dampness than the common hollow wall.

STAIRCASES.

The staircases consist of four flights; two at either end of the building. While being convenient and easy of access from all parts of the building, they are yet sufficiently isolated to be free from the usual objection of noise, and are moreover absolutely fireproof. They are constructed with iron treads and risers, securely fastened to string-pieces, also of iron that are bolted directly to the brick enclosing-walls. The

top surfaces of all treads are to be covered with rubber, to prevent slipping. All platforms and landings are to be formed of granite slabs 8" thick. The stairs are formed with two "runs" for each flight, with landings midway, this being done to secure an easy ascent. The stairs are all 5' 0" wide; all landings 5' 0" X 11' 0", risers, 7½", treads 11"; they are well lighted at all points by ample windows placed on each landing. An iron hand-rail, bolted to the walls, runs around on all sides at a suitable height There is no wood-finish of any kind, with the exception of door and window casings, in the staircase halls. The sidewalls are all of face-brick laid in black mortar with struck joints. These walls, when hard, are to be treated with a coat of liquid filler, and then varnished in two coats, thus forming a perfectly hard surface, not easily marred or soiled.

HAT AND CLOAK ROOMS.

In all our school buildings of the present day, the hat and cloak rooms have been more or less objectionable, especially in wet weather. Children coming in with wet garments hang them in narrow rooms, poorly heated and lighted, and usually unventilated, where they are allowed to steam in a close and unwholsome atmosphere during the session, and at its close are put on by the child in a worse condition than when taken off. An attempt has been made to remedy this evil in the construction of this building. In the main halls, which are spacious, and which are to be heated and ventilated in the same manner as the school-rooms, have been placed the hat and cloak rooms—two for each school-room. These rooms, instead of being lathed and plastered in the usual manner, are simply partitions of ash 8' 0" high, entirely open at the top, and so arranged that only the supporting-posts run down to the floor. The portion of the partition between the posts is kept 4" from the floor, giving a free circulation of air throughout the rooms. Damp or uncleanly clothing hung in these rooms during the session instead of being filled with foulness arising from the confined atmosphere will become purified by the constant circulation of pure air,—the impure air being disposed of through the main hall ventilators.

LIGHT.

All eminent writers on School Hygiene have called attention and dwelt with much stress upon the importance of abundant light properly distributed in our school rooms. That the light should come from the left side and be introduced at nearly right angles to the floor-line is an established rule among those versed in school matters. Upon the actual amount of glass required by each pupil authorities differ. Dr. Lincoln states that the size of the windows, taken collectively, should equal at least one-sixth of the floor space. Cohn, the German writer, requires one-fifth, or 30 inches to the foot. Some of the highest authorities require from 300 to 350 square inches of glass for each pupil; this coincides very nearly with Cohn, but Dr. Lincoln does not consider that, in our school-rooms that have a greater depth than those referred to by the above-mentioned authorities, the amount mentioned by them is enough.

In the Bridgeport school-house the window-stools have all been kept 4' 0" from the floor, and the window openings are carried up to within one foot of the ceilings. The size of the windows, taken collectively, equals, in the corner rooms, one-sixth of the floor-space, allowing 50 pupils per room, and provides 434 square inches of glass per pupil. In the middle rooms, the floor-space is seven times that of the glass surface, and, allowing 50 pupils per room, will give to each 403 square inches of glass. In the corner rooms the seats are so arranged that the light comes always from the back and left—in the middle rooms it comes only from the left.

In the High School room, the glass surfaces, taken collectively, equal one-sixth the floor-space; allowing 200 pupils for this room, will give to each pupil 384 square inches of glass surface.

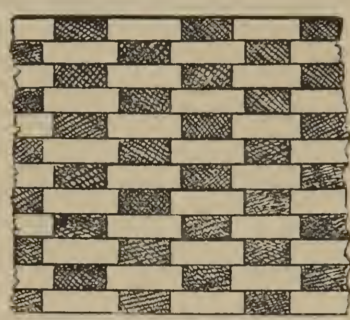
FLOOR, AND CUBIC FEET OF SPACE ALLOWED EACH PUPIL.

In the corner rooms, allowing 50 pupils per room, each pupil will have 20.50 square feet of floor-space, and 266 cubic feet of air. In the middle rooms each pupil will have 21 square feet of floor-space, and 273 cubic feet of air. In the

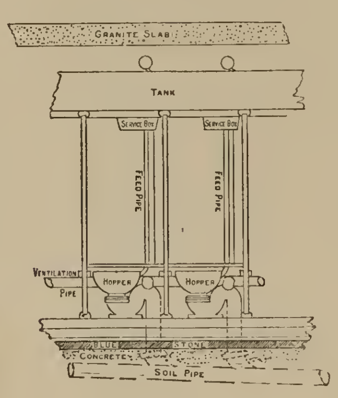
High School, allowing 200 pupils, each pupil will have 17 square feet of space, and 441 cubic feet of air. While the floor-space in the High School room is somewhat smaller than the highest authorities require, the cubic contents are largely in excess of the most exacting, and it must be taken into consideration that this room is seldom occupied by the entire number of pupils for more than a few moments at a time, as the recitation-rooms used in connection with it are, during the school session, in constant use. It should also be remembered that the number of pupils calculated for each room is their extreme capacity. It is to be hoped that no teacher will be burdened with more than 44 pupils, although I have based my calculations on a larger number.

THE WATER CLOSETS AND THEIR CONSTRUCTION.

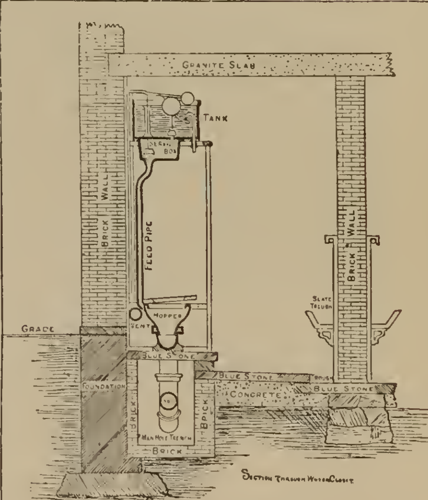
The demands of modern civilization require that we provide, either within our school-buildings or in close proximity to them, water-closets for the use of the pupils. There can be no doubt but that much harm is done to children, in many schools in our State, from the bad sewerage and careless arrangement of water-closets. It has been said that privies placed under the same roof which shelters the school should not exist, for a moment. I do not consider that this rule should be simply applied to privies, but that the groups of water closets that are required in all our large schools should come under the same head; they should in no case be placed directly under school rooms in the basement, as contamination will surely follow sooner or later. They should be, if not wholly, at least partially isolated from the building, and those for the boys removed as far as possible from those for the girls. The teachers' water-closets can, I think with safety, be placed in the building, that is if they are carefully ventilated; these water-closets will be used understandingly and are not liable to become unwholsome, but the pupils' closets, even with the most careful watching, are liable to become foul from the habit so prevalent among children (I wish I could say that the habit was confined to children alone!) of making the closet a common receptacle for all kinds of garbage.



Method of Laying Brick around Stoves in Water Closets



Elevation of a portion of the Closets



Section through Water Closet

In the Bridgeport school-house, the closets for the pupils have been placed at either end of the building under the entrance steps, far removed from each other, securing a complete isolation of the sexes. They are also completely shut off from the main school building by the intervening staircase halls ; by this arrangement, ease of access is obtained, combined with complete isolation, obviating the danger of contaminating the main school-building.

The water closets have been constructed with a view to having as little wood-work as is possible with the requirements of comfort. The main floor is to be of blue-stone flagging 4" thick, laid in Portland cement ; this is laid on a gentle incline to a certain point, to secure a good drip or wash from all points of the room. The side-walls are of brick, treated in the same manner as has been before mentioned in the description of the entrance-halls. The ceilings will be formed by the bottom of the granite slabs that are used for the floors of the vestibule, porch and outer halls. The casings, doors, and seats for the closets comprise the entire wood-work: these are of ash and are treated to a coat of filler and then varnished in two coats. The partition between each hopper is to be of slate $1\frac{1}{4}$" thick, 7' 0' high by 2' 6" broad. These slate partitions are held in position by iron floor and wall-pieces and caps of the same material (see accompanying drawings). The floor upon which the hoppers stand is raised one step above the main floor of the closet (see drawing), and is also composed of blue-stone flagging 4" thick, a hole being cut through this stone for the outlet of the hopper. The closet that is intended to be used is the Hellyer Short Artizan Hopper. This closet combines more good points, in the writer's opinion, than any at present known to him. Its chief point of excellence is its simplicity of working, and the fact that it is entirely of earthen-ware. There are no pans, valves, or plungers to become foul or get out of order: it is, in fact, an earthern hopper of improved shape, fed by a continuous tank to which is attached for each bowl a serving-box. When the seat is occupied, by a simple device a valve is raised, and the serving-box filled with water from the tank, at the same time a small stream is permitted to trickle into the hopper, wetting

the sides and preventing the adhesion of excretion to the bowl. When the seat is relieved of its weight, the valve before referred to is closed, another one opened and the contents of the serving-box (some three gallons) suddenly discharged through a large pipe connected with the flushing rim into the bowl of the hopper, carrying all solid matter through the trap, As I have said before, these hoppers, both bowl and trap, are of white earthen-ware, they are to be securely bolted to the blue-stone and left entirely open and exposed to the view. The seat is supported by the slate partitions, on which are bolted slate cleats. The chain operating the service-box and the feed-pipe are both enclosed in an iron pipe, so as to be completely inaccessible to the pupils.

The tank and service-boxes are of iron, painted. Directly under the platform on which the hoppers stand, there is to be constructed a man-hole trench, to be built of brick, coated with asphalt; the top is formed of the blue-stone that the hoppers rest upon. This man-hole is 2' 0" broad by 3' 6" high, and is large enough to permit of a man crawling through it to inspect the pipes. This trench is to have an iron register at one end for the admission of pure air, and at the other is connected directly with the ventilating shaft. In this trench are to run the soil-pipes from the hoppers; these are to consist of 6" cast-iron pipes with 4" Y joints for each hopper. These pipes are caulked with moulten led and then covered with two coats of asphaltum to prevent rust. By the arrangement of this trench the soil pipe and its connections are always accessible; even should a leak occur in any of its joints that was not at once discovered, the stench arising from such a cause would not enter the building but pass off through the ventilating flue. The urinals are placed along the inside division walls: they are to be constructed with slate backs and troughs put together in the most approved manner, the trough being supported by brass brackets; the back is arranged with a neat cap of slate, under which is run a water-pipe perforated with small holes so as to secure the complete wetting of the entire back at all times. Underneath this trough, in the floor, there is another trough, the bottom and one side being of blue-stone and the other formed by the slate back; this trough has an

inclined surface and is intended to carry off all drippings or slopping that may occur in or about the closets or urinals. At its outlet it is trapped with a deep running trap and then connected with the main drain. This arrangement will enable the janitor, at the close of each day's session, to thoroughly wash down with a hose the entire room.

Upon the inside walls of the rooms that are occupied by the closets have been placed ventilating flues, two for each of the closets. These flues are of large size, and run up through the building, entirely independent of all other flues, to a point far above the main cornice-line Through these flues the extension of the soil-pipes of each section of hoppers is carried, and there is also connected with the flues a vent-pipe, running under the seats just above the trap of each hopper. Lastly, the trench in which the soil-pipe runs is also connected. The lower portions of the flues, that is, those parts of them that come directly in the rooms occupied by the water-closets, are enlarged into a circular form (see plans), this being done to permit of the introduction of a small stove in the bottom of each flue, and this stove is to be kept running ALWAYS, both winter and summer, as the writer believes that this is the ONLY WAY to secure a steady up-current at all times under the varying conditions of the atmosphere. The brick-work around the stoves is laid in open work (see sketch), and on the inside covered with wire netting. There is also an iron door provided for each flue. By this arrangement many points are gained: not only are the hoppers and soil-pipes perfectly ventilated, but any stench arising in the rooms is quickly removed by the strong up-current through the flues. Again, in the winter, the stoves, two in each room, will be ample for heating purposes, while in summer, by a simple device, the direct radiation is shut off from the room, and thrown entirely up the flue.

The teachers' water-closets, situated two on each floor, are to be of the same pattern as those described, fitted up in the same manner as the ordinary house-closets, but with special reference to their construction and ventilation.

NOTE.—The soil-pipes for the teachers' closets in the main building are laid in a trench in the same manner as described above; the main drain runs into a man-hole just outside of

the building, where the three lines of soil-pipes (one from each section of hoppers, and one from the teachers' closets) are brought together just above a deep running-trap. This man-hole is covered with a blue-stone flag, is carefully ventilated, and easy of access. There is also connected, just above the trap in this man-hole, the rain-water drains connected with the leaders from roof, so as to secure during every rain a thorough scouring-out of all the drains and their connections.

The reader, by studying the accompanying plans and sketches, will be enabled to readily understand the general arrangement and working of this system.

HEAT AND VENTILATION.

It is generally admitted, on all sides, that the most practical, economical, and surest way of heating our buildings, at the present day, is steam. Granting that steam is to be our medium, it next becomes a question of how it shall be used. There are, at this writing, two methods in general use, these being known respectively as the direct and indirect systems. The direct system means the placing of radiators or circulation-pipes in each and every room required to be heated. The indirect system consists in placing all the pipes or radiators in boxes in the basement. Pure, cold air is brought into these boxes, and by passing through the coils of heated steam-pipes is warmed to the degree required. The heat generated in the boxes is then conveyed to the various rooms through tubes or pipes, in the same way that heat is usually conducted from our hot-air furnaces. Both systems have many strong advocates, but as far as the writer's investigations and researches have led him, he has found, among men that have simply the heating of a room in view, the direct system in favor; but among those who have not only the actual heating, but the supplying of the room with fresh, pure air at all times, the indirect system is invarably adopted. From the personal investigations and practical experiments the writer has made from time to time, he is convinced that far better results can be obtained by this method than by any now known to him.

It has therefore been adopted in the new building for this city. It may be said in objection to this system that the amount of fuel required to heat a given amount of space is

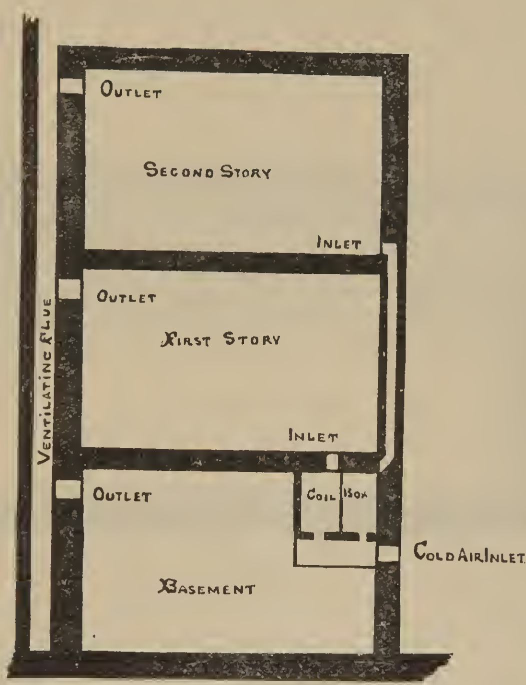


Fig 1

largely in excess of that required by the direct plan; this is in a measure true, but not to the extent supposed. Again, it has been said that it is impossible to heat exposed rooms by the indirect plan, without an enormous apparatus. This also is a mistake, for neither is an extravagant use of fuel nor a

gigantic apparatus required, *if the apparatus is properly arranged and understandingly handled.* The trouble has been not from the inability to produce heat, but from the extraordinary loss of heat, this being occasioned in many cases by the position of the introductory flues, and in other cases by that of the out-going ventilating-ducts. It should be our aim to utilize every particle of heat entering the room before we allow it to escape; it is certainly folly to bring in vast quantities of pure, warmed air at the floor-level of a room, and

FIG. 2

send it out with equal rapidity at the ceiling-level, without having traversed the room, outside of an almost direct line drawn from the incoming to the outgoing register; yet in many cases our registers are so arranged that it is impossible to get any different results.

I have before said that there is a general unity of opinion among experts as to the feasibility of indirect heating, but in regard to the placing of the heating surfaces in the cellar, and the position of the incoming and outgoing registers, there is a wide diversity of opinion.

I shall endeavor briefly to describe some of the principal methods in common use, and the objections that I have to

them, before describing the system adopted in the Bridgeport school-building. First, the placing of the coil-boxes in the basement, on the outer walls under the rooms to be heated (Fig. 1), and the introduction of the warmed air at the floor and its removal at the ceiling-level upon the opposite side of the room. The objection that I have to this system are:

1. That in a building like the Bridgeport school there would have to be placed in the basement at least six separate coil-boxes for the generation of heat, arranged one under each room: that by placing these boxes in the basement rooms the

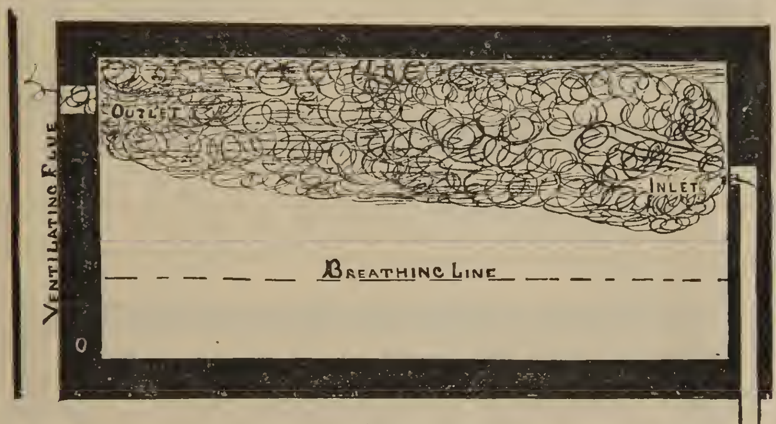


FIG 3

rooms are rendered entirely unfit for school purposes, and their utility for play-room greatly crippled.

2. That by placing these boxes far away from the center of the building, where the boilers are presumably located, a large amount of additional piping becomes necessary throughout the basement.

3. The boxes being placed on the outer walls of the building, there is danger of the pipes freezing; constant watching and attention is required to prevent this and to insure their proper working.

4. That the introduction-ducts or flues running up the outer exposed walls of the building lose a great deal of heat by

their proximity to the cold : that this loss of heat cannot be wholly obviated even by the most expensive construction : that

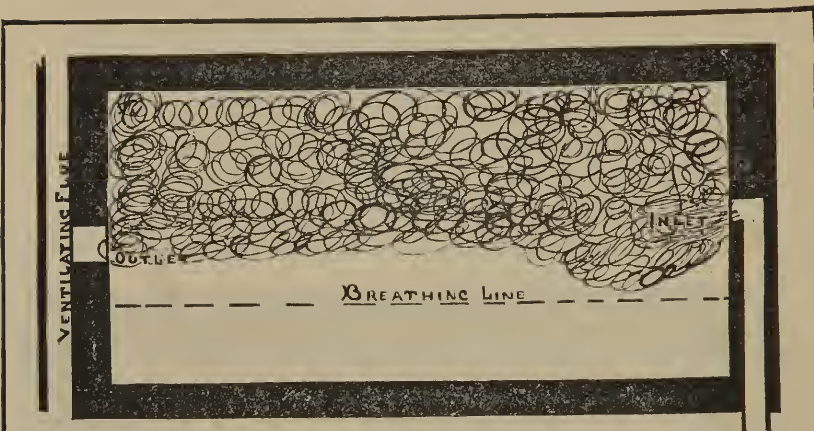


Fig 4

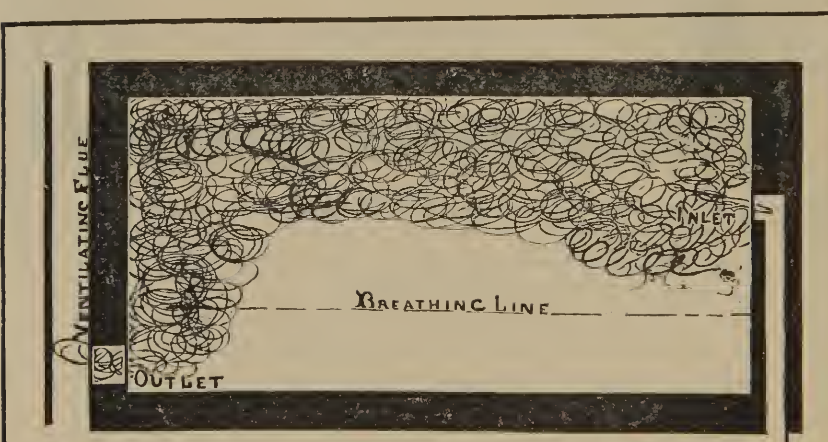


Fig 5

a large addition to the actually necessary heating surface is required to overcome this loss of heat, caused by the exposed position of the flues.

Lastly: That the air entering upon the outer wall at the floor, and being removed on the inner wall at the ceiling-level, does not benefit the occupants of the room as it should. The action of the air as it enters is rapidly upward to the ceiling, where it stratifies, then along its surface to the outlet, as indicated in Fig. 2. The entering air is warm and light, and naturally rises and flows across the top of the room to the nearest outlet. The foul air of the room, being heavy with impurities, remains at the bottom, becoming constantly more contaminated. There is no doubt a certain amount of radiation or mixing going on, but the great bulk of the pure

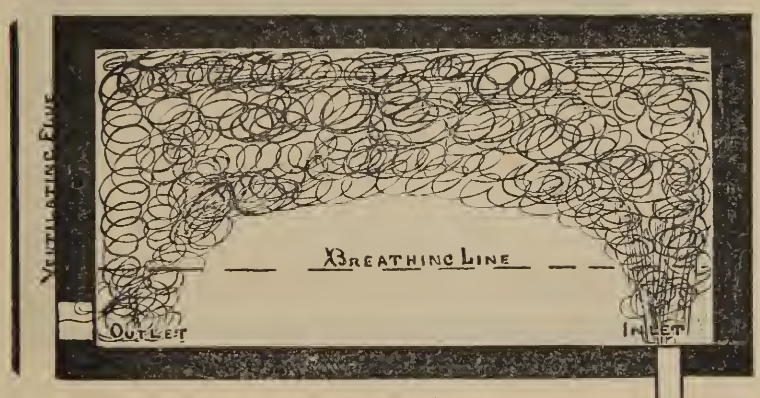


FIG. 6.

warmed air entering the room takes the short cut across it and up the ventilating-duct, as shown in Fig. 2. This action of the warm air occasions, as may be readily seen, an enormous loss of heat, without accomplishing the very points aimed at, the utilization of every particle of heat, before it is allowed to escape, and the thorough mixing of the pure incoming air with the air already in the room. If any one doubts the correctness of the action of air as herein described, let him fill the incoming flue with smoke, that can be readily seen, and watch its course as it enters, flows upward and outward, and see where the great mass of it goes. The dotted lines on

these sketches indicate the breathing point of a person sitting.

It may be well to explain that in the experiments that I have made, the outlets have been at least *twice as large* as the inlets, and that there has always been heat in the outgoing flues to produce a strong up-current, as I believe this to be the *only* sure way to produce a constant outward flow of air. In Fig. 3, the outgoing flue is in the same position, but the incoming flue has been raised about two-thirds of the way towards the ceiling. In Fig. 4, the flues have been placed on about the same level, but with no better results. In Fig. 5, the outgoing flue

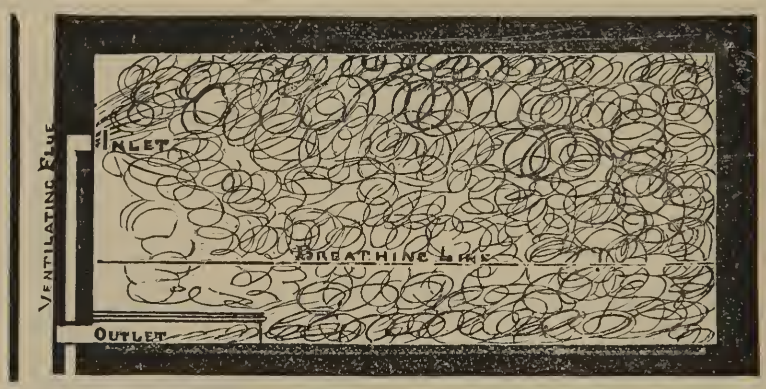


FIG 7

has been placed at the floor with the results shown in the sketch. In Fig. 6, both flues are at the floor-level, with better results than have yet been obtained, but still far from satisfactory. I have thus tried to show the general action of incoming and outgoing currents of air by the placing of the introduction-flues on the outer walls, and the outlets on the inner. The second method in general use is the placing of the coil-boxes upon the inner wall, and the removal of the foul air at the opposite or outer side of the rooms. I consider the placing of the coil-boxes on the inner wall a great improvement on the other method, as by this plan they are centralized, extensive piping is saved, and the danger of freezing obviated.

The placing of the exhaust-flues on the opposite side of the room I believe to be open to the same objections that I have described in the first method. The action of the hot air, from the points where it is introduced toward the various outlets, is the same as in the sketches already shown, and will be readily understood by the reader.

In the Bridgeport school the coil boxes for the heating of the various rooms have all been placed in the main ventilating shafts in the *center* of the building, and the air conveyed from them through these shafts to the rooms by means of metal tubes. The air enters the inner corner of the room about eight feet from the floor, the corner being clipped (see plans) so as to form a flat surface for the register-opening; underneath the register the space is utalized for a closet for the use of the teacher. The outgoing flue has been placed directly under the platform, which is located in the *same corner* as the introduction flue. This platform measures 6'X12', and is supplied with casters, so that it can be moved at any time it is necessary to clean under it. Its entire lower edge is kept about 4" from the floor, to give a full circulation of air under it at all points. The action of the incoming air is rapidly upward and outward, stratifying as it goes towards the cooler outer walls, thence flowing down their surfaces to the floor and back across the floor to the outgoing register on the inner corner of the room. By this method all the air entering is made to traverse with a circular motion (see Fig. 7) the entire room, before it reaches the exhaust-shaft, and there is a constant movement and mixing of the air in all parts of the room continually going on. All the heat entering is utilized, and I believe that if the supply and exhaust-flues are properly balanced as to size, that there can be a very small loss of heat.

The inlets are all intended to be large, and the flow of air through them moderate and steady. The air is not intended to be heated to a very high temperature; the large quantity introduced is expected to keep the thermometer at about 68° at the breathing-level The school-rooms contain on an average about 13,000 feet of air, or 260 cubic feet per pupil. It is proposed to supply each pupil with 30 cubic feet of air each minute, or 1,800 cubic feet per hour. Allowing 50 pupils to

each room, this will necessitate the introduction of 90,000 cubic feet of air into the room each hour, and will change the

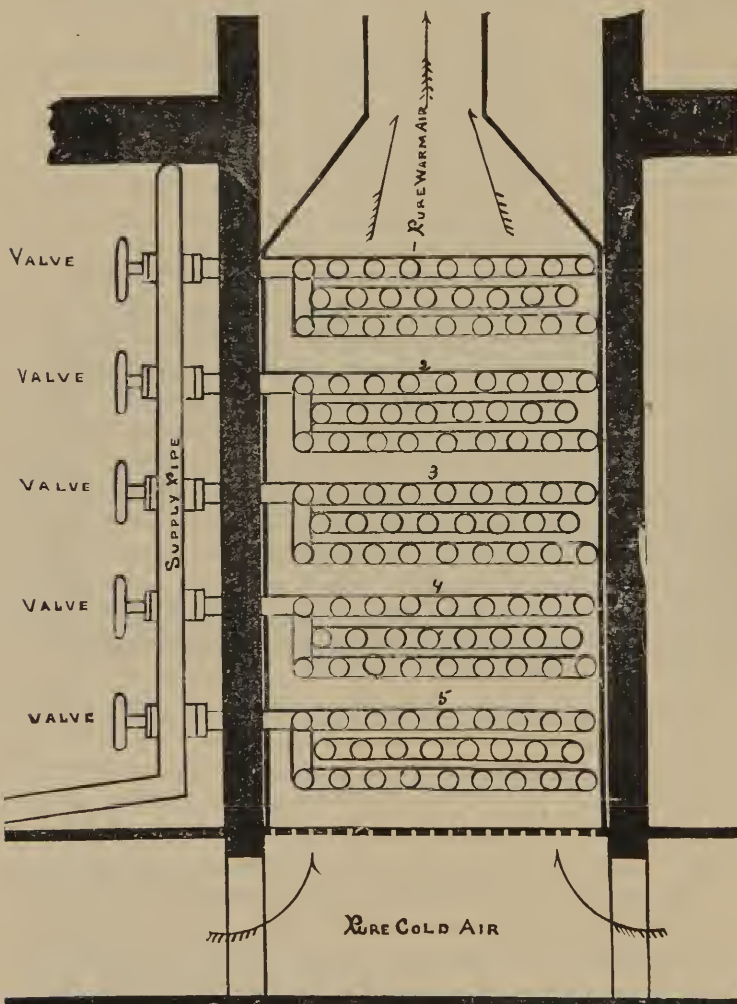


Fig 8

air of the room 6.92 times within the hour, or once in about eight minutes. These calculations are based on a difference

of 30° in the temperature. In the exhaust flues there are placed coils to produce a strong up-current at all times; heat is also obtained from radiation from the introduction and boiler-flues, which run through the foul-air shafts.

Trouble has always been found in regulating the supply of warmed air obtained by the indirect system, owing to the inability to control the heating surfaces. The usual way of constructing the apparatus has been to place in the coil-boxes sufficient steam-pipe to heat the room in the coldest weather. The pure, cold air passing over the pipes becomes heated to the desired temperature, and is then carried to the rooms; this answers very well during the coldest weather, but as the weather moderates and less heat is required, the only way to regulate it has been to close the registers. This not only lowers the temperature of the room, but shuts off the supply of pure air entering. This fault has been remedied in the Bridgeport school-house as follows: The heating surface for each room is inclosed in separate cases or jackets (see Fig. 8) of metal, and are then subdivided into five sections, so arranged that any number of sections or the whole may be used at pleasure,—that is to say, that any one, two, or three parts may be used at discretion. In extreme cold weather the whole five sections are in use; in moderate weather two or three, and when a small amount of heat is required, only one. By this plan the supply of pure air remains always the same, but the degree to which it is heated is changed by the opening or closing of a valve. (See sketch.)

The arrangement of all the heating and ventilating apparatus in the center of the building renders it convenient and easy to manage, economical in its construction, and effective in working. The advantage is also obtained of having all speaking-tubes, call-bells, and water-pipes run through the ventilating-shafts, where they are always accessible, as each shaft is provided with an iron ladder. This system has not only been introduced into each room, but into the halls as well. There are placed, moreover, in the halls foot-warmers, that are indicated on the plans. These warmers are simply steam-pipes encased in tin boxes arranged between the floor joists; the pipes being packed in sand to temper the heat,

and are covered at the floor-level with checkered iron plates set flush with the floor. The tin cases referred to are water-tight and have a drip-pipe running down to the boiler-room, so that in case of a leak no damage may be done to the building.

The boiler-room floor is sunk some six feet below the level of the ground floor to insure a drip of all return-pipes from the coils. The cold-air inlets are on four sides of the building, the openings being about eight feet from the ground; these inlets are connected so that, whatever way the wind may be, a supply of pure cold air is always assured.

I have thus far spoken only of winter heating and ventilating; for summer ventilation I believe that there are no better inlets for the air than the windows. There are many devices that may be arranged in them that are simple and effective. It is not necessary to describe them here. The outlets, however, need a brief description; it is intended not only to use the outlet under the platform, but by a simple device the incoming register for warm air in winter is made to connect with the main outlet in summer, so that two outlets are provided during the warmer months. The upgoing current in the ventilating shafts is maintained in summer, as well as in winter, by heat; there being placed at the bottom of each shaft a stove, which is to be used constantly when the boilers are not in use, insuring an equally strong up-current in summer as in winter.

I would say in conclusion that many interesting experiments have been made and important facts established. These experiments have principally been made with a model of about one-sixth the capacity of the school-rooms. They have always resulted most satisfactorily, and have proved to the writer the correctness of the principles herein advanced against the objections commonly raised that heat brought into the room on the inner walls will not sufficiently warm the outer walls. He would say that in every test yet made the registration of carefully graded thermometers has been from 1 to 2 degrees warmer near the outer wall than near the inner, showing conclusively that the flow of heated air is rapidly towards cool surfaces, and that if its volume is as it should be it will coun-

teract the cold radiating from the outer walls and render the temperature of the air in their immediate vicinity comfortable. Many other interesting facts have been established, and much useful data obtained, but I have neither the time nor the space here to describe them. I have purposely omitted in this paper all figures not actually necessary, aiming to make it a simple statement of the writer's views, fortified by the results of actual experiments. If any should desire more minute details than are here given, by communicating with the writer he will willingly furnish all the information required, or should any be interested enough to come to this city, he will be pleased to go through with them some of the experiments here mentioned.

The building has been described throughout as it was designed to be built by the architect; some modifications have been found necessary, however, during the progress of the work.